



2004 EPA STAR Graduate Fellowship Conference Next Generation Scientists—Next Opportunities

Bacteria-mediated Bioremediation of Benzene in a Shallow, Stratified Lake

Environmental Issue

Lake Mishawum is contaminated with toxic Volatile Organic Compounds (VOCs)

- Artificial, shallow lake is stratified year round
- Methane-rich anoxic bottom layer, oxic upper layer
- Groundwater inputs contaminated with toxic VOCs
 - benzene, toluene and phenol

Studies of Lake Mishawum suggest the major sink for benzene is bioremediation by bacteria¹

- 80% of the benzene entering the lake is degraded
- Rates of degradation highest at oxic/anoxic interface
 - High methane, limited oxygen
- Degradation stopped with bacterial enzyme inhibitors
 - Picolinic Acid

Methane-oxidizing bacteria (methanotrophs) may be the key bacterial population in bioremediation

- Methanotrophs are known to oxidize benzene
 - benzene→phenol→catechol (readily degraded)
 - Unique enzyme methane monooxygenase.²
- Methane and oxygen present at interface

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Citations: Wick, L. Y. & P. M. Gschwend. 1998. Environ. Sci. Technol. 32:1319-28. 2. Hanson, R. S. & T. E. Hanson. 1996. Microbiol. Rev. 60:439-71. 3. McNeill, K., Wick, L. Y., Rojo, M., Kane, E. S., & P. M. Gschwend. Manuscript In prep. 4. Wick, L. Y., McNeill, K., Rojo, M., Medilanski, E., & P. M. Gschwend. 2000. Environ. Sci. Technol. 34:4354-62.

Scientific Approach

Hypothesis:

Methane-oxidizing bacteria are facilitating the high rates of benzene disappearance observed at the oxic/anoxic interface of Lake Mishawum.

Research Questions:

What is the diversity and abundance of methanotrophs at the oxic/anoxic interface in Lake Mishawum?

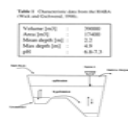
- Molecular techniques including PCR and QPCR
- Amplify, identify, and quantify methanotroph genes
- Culturing of methanotrophic isolates

Do methanotrophs play a key role in the observed disappearance of benzene at the oxic/anoxic interface?

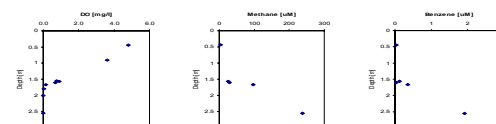
- Biodegradation rates of benzene at oxic/anoxic interface
- Inhibitors of methanotroph activity vs. other bacteria

Field Site

Lake Mishawum

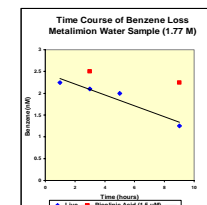
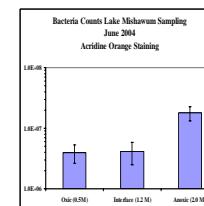


Depth Profiles of Dissolved Oxygen, Methane and Benzene in Lake Mishawum



Results

Phylogenetic tree: particulate methane monooxygenase gene



Issue Impact

Bioremediation of VOCs in unique environments

- Comparisons of bioremediation in oxic and anoxic environments
- Bioremediation at an interface
- Bacterial communities and processes involved

Engineered solution to groundwater contamination

- Stratified lake shows high rates of VOC degradation
- Engineered solution to groundwater VOC contamination.